

August 1999

# CHEMICAL AND BIOLOGICAL DEFENSE

## Coordination of Nonmedical Chemical and Biological R&D Programs



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GAO/NSIAD-99-160

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United States General Accounting Office  
Washington, D.C. 20548

National Security and  
International Affairs Division

B-282700

August 16, 1999

The Honorable Robert C. Byrd  
Ranking Minority Member  
Committee on Appropriations  
United States Senate

The Honorable Carl Levin  
Ranking Minority Member  
Committee on Armed Services  
United States Senate

Since the Persian Gulf War, Members of Congress have raised concerns regarding the adequacy of technology used by the Department of Defense (DOD) to detect, identify, prepare for, and protect troops against chemical and biological (CB) weapons.<sup>1</sup> In 1993, the National Defense Authorization Act for Fiscal Year 1994 (P.L. 103-160) directed the Secretary of Defense to take actions designed to improve the Department's CB defense capabilities, including coordination and integration of all CB defense programs into what is now the CB Defense Program. More recently, concerns that terrorists might move beyond using conventional weapons to CB devices led Congress to authorize the federal government to improve domestic capabilities to respond to such incidents. With the initiation of these domestic preparedness programs in fiscal year 1997, federal research and development (R&D) efforts to develop nonmedical CB defense technology expanded considerably, and they continue to grow.<sup>2</sup> According to the White House, the President's fiscal year 2000 budget request includes over \$10 billion to combat terrorism. Almost \$1.4 billion is for programs specifically aimed at terrorist threats from chemical, biological, radiological, or nuclear weapons, an amount that exceeds the funding of less than \$1 billion for military programs to counter CB threats.

<sup>1</sup>See Chemical and Biological Defense: Emphasis Remains Insufficient to Resolve Continuing Problems (GAO/NSIAD-96-103, Mar. 29 1996) and Chemical Weapons: DOD Does Not Have a Strategy to Address Low-Level Exposures (GAO/NSIAD-98-228, Sept. 23, 1998).

<sup>2</sup>Nonmedical technologies refer to technologies for detecting, identifying, protecting against, or decontaminating personnel and equipment of CB agents. By contrast, examples of medical R&D include the development of prophylactics such as vaccines, medical diagnostics for determining exposure to chemical or biological agents, and therapeutic drugs or procedures for countering the effects of exposure.

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In response to your request, we examined the coordination of federal R&D efforts to develop nonmedical technology related to CB defense. Specifically, we (1) identified federal programs that conduct nonmedical CB defense-related R&D and (2) described the existing mechanisms for coordinating these programs. A companion report, Chemical and Biological Defense: Program Planning and Evaluation Should Follow Results Act Framework (GAO/NSIAD-99-159, Aug. 16, 1999), examines the extent of DOD's application of the Government Performance and Results Act's outcome-oriented principles to the CB Defense Program.

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## Results in Brief

Four federal programs that currently fund R&D of nonmedical CB defense technologies are:

- Department of Defense's Chemical and Biological Defense Program,
- Defense Advanced Research Projects Agency's Biological Warfare Defense Program,
- Department of Energy's Chemical and Biological Nonproliferation Program, and
- Counterterror Technical Support Program conducted by the Technical Support Working Group.

All these programs pursue R&D ranging from applied research to prototype development. Two of these programs, the Chemical and Biological Defense Program and Biological Warfare Defense Program, develop technologies primarily for military warfighting applications. The other two programs develop CB defense technologies primarily to assist civilians responding to terrorist incidents.

The current formal and informal program coordination mechanisms may not ensure that potential overlaps, gaps, and opportunities for collaboration are addressed. Coordinating mechanisms lack information on prioritized user needs, validated CB defense equipment requirements, and how programs relate R&D projects to these needs. In particular, domestic preparedness needs are specified with significantly less detail

than military needs.<sup>3</sup> Furthermore, two programs—those in the Defense Advanced Research Projects Agency and the Department of Energy—do not formally utilize user requirements in planning their R&D goals. More detailed information about user needs, validated CB defense equipment requirements, and how user needs relate to R&D projects may allow coordination mechanisms to better assess whether overlaps, gaps, and opportunities for collaboration exist.

Agency officials are aware of the deficiencies in the existing coordination mechanisms and some have initiated additional informal contacts in response. Informal coordination between the Department of Defense and the Department of Energy has been particularly active.

We are making no recommendations at this time.

## Background

In the last decade, concerns about the possible use of CB weapons led both Congress and the executive agencies to implement new or expanded programs to address these threats. In 1993, Congress established DOD's CB Defense Program in an effort to coordinate and integrate across the military all CB defense programs from R&D through procurement.<sup>4</sup> DOD initiated a stand alone R&D program in biological defense within the Defense Advanced Research Projects Agency (DARPA) in fiscal year 1997, and in October 1998 it established the Defense Threat Reduction Agency to administer the CB Defense Program as well as to address other emerging military threats. Following the use of a chemical agent by terrorists in Japan, civilian-oriented programs emerged through Congress's passage of

<sup>3</sup>In *Combating Terrorism: Analysis of Potential Emergency Response Equipment and Sustainment Costs* (GAO/NSIAD-99-151, June 9, 1999), we found that there is no assessment that would provide a basis for clearly defined and prioritized equipment requirements based on threat and risk, and there is little consensus among federal, state and local officials on the types of equipment needed for civilians to prepare for a CB terrorist incident. Moreover, in 1998 we reported that some local jurisdictions were deciding on equipment purchases without the benefit of formal threat and risk assessments based on valid threat data. See *Combating Terrorism: Observations on Crosscutting Issues* (GAO/T-NSIAD-98-164, Apr. 23, 1998); *Combating Terrorism: Threat and Risk Assessments Can Help Prioritize Target Program Investments* (GAO/NSIAD-98-74, Apr. 9, 1998); *Combating Terrorism: Observations on the Nunn-Lugar-Domenici Domestic Preparedness Program* (GAO/T-NSIAD-99-16, Oct. 2, 1998); and *Combating Terrorism: Opportunities to Improve Domestic Preparedness Program Focus and Efficiency* (GAO/NSIAD-99-3, Nov. 12, 1998).

<sup>4</sup>P.L. 103-160, sec. 1701, Nov. 3, 1993.

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the Defense Against Weapons of Mass Destruction Act of 1996.<sup>5</sup> This act initiated a set of domestic preparedness programs, including R&D programs, for improving domestic capabilities to respond to terrorism involving chemical, biological, radiological, and nuclear weapons.

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## Four Federal Programs Fund Nonmedical R&D Addressing CB Threats

Four federal programs that currently fund nonmedical R&D addressing CB threats are:

- DOD's CB Defense Program,
- DARPA's Biological Warfare Defense Program,
- Department of Energy's (DOE) CB Nonproliferation Program, and
- Counterterror Technical Support Program conducted by the Technical Support Working Group (TSWG).

The objective of DOD's CB Defense Program is to enable U.S. forces to survive, fight, and win in chemically and biologically contaminated environments. DARPA's program funds R&D projects supporting revolutionary approaches to biological warfare defense, emphasizing high-risk, high-potential technologies. DOE's program funds R&D to develop advanced technologies to enable the United States to more effectively prepare and respond to the use of CB weapons. Finally, TSWG is an interagency working group whose mission is to facilitate interagency R&D for combating terrorism primarily through rapid research, development, and prototyping.<sup>6</sup> The TSWG's subgroup on Chemical, Biological, Radiological, and Nuclear Countermeasures oversees, among other activities, the development of techniques to detect, protect from, and mitigate CB weapons.

These programs conduct R&D in similar areas as well as in support of similar user communities. In all four programs, R&D activities include applied research and initial prototype development; two programs, DOD's CB Defense Program and DOE's CB Nonproliferation Program, also engage

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<sup>5</sup>This act was contained in the National Defense Authorization Act for Fiscal Year 1997 (title XIV of P.L. 104-201, Sept. 23, 1996) and is commonly referred to by its sponsors' names: Senators Nunn, Lugar, and Domenici.

<sup>6</sup>TSWG is funded primarily through the Counterterror Technical Support Program within DOD.

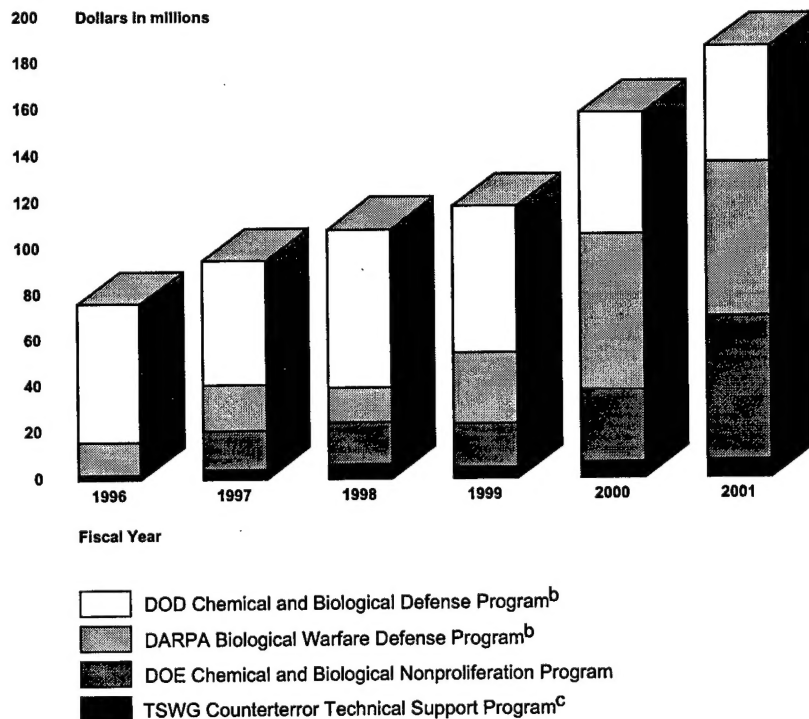
in basic research.<sup>7</sup> The R&D funded by DOD's and DARPA's programs support the development of technologies principally for military warfighting applications. The end users of such technologies may be a single military service, such as the Army, or multiple services. The R&D conducted by DOE's program and by the TSWG's Subgroup on Chemical, Biological, Radiological, and Nuclear Countermeasures support the development of technologies for civilian end users, which include federal, state, and local emergency response personnel.

The funding for nonmedical R&D in the DARPA and DOE programs has been increasing, and combined are projected to be greater than nonmedical R&D funding for DOD's CB Defense Program for fiscal years 2000-2001. The funding levels of basic research, applied research, and prototype development for these programs are shown in figure 1 for fiscal years 1996-2001.

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<sup>7</sup>Basic research involves the investigation of fundamental scientific knowledge, such as the basic physical properties of CB agents. Applied research refers to scientific investigation directed toward a technical goal, such as developing and evaluating the feasibility of proposed detection technologies. Applied research generally tests such technologies within a controlled laboratory environment. Prototype development involves developing a piece of equipment in order to show the practical utility and feasibility of a technology. In general, the initial prototype must be able to perform in an environment similar to that in which it will ultimately be used, though it may not be able to withstand all the stresses of operational use. Two other types of R&D activities, conducted primarily by DOD, are Demonstration/Validation and Engineering and Manufacturing Development. These two activities are part of DOD's acquisition cycle, and include the testing and evaluation of technologies.

**Figure 1: Actual and Projected Funding for Nonmedical Basic Research, Applied Research, and Prototype Development Addressing Chemical and Biological Threats<sup>a</sup>**



<sup>a</sup>All funding amounts are in then-year dollars.

<sup>b</sup>DOD and DARPA budgets include only nonmedical R&D in the DOD budget activities of basic research, applied research, and advanced technology development. The fiscal year 1997 DOD CB Defense Program budget excludes DARPA funds, which were consolidated into the CB Defense Program for fiscal year 1997 only.

<sup>c</sup>Our figures for TSWG's budget only include funding originating in DOD for the Chemical, Biological, Radiological, and Nuclear Countermeasures Subgroup. Funding for fiscal years 2000-2001 is estimated assuming the same annual percentage change as total TSWG funding from DOD.

Sources: DOD, DARPA, and DOE.

## Current Mechanisms May Not Ensure Effective Coordination of R&D Programs

These four programs need to coordinate their R&D efforts because they pursue many of the same capabilities and may contract with many of the same laboratories to perform R&D work. The current formal and informal mechanisms to coordinate among these programs may not ensure that potential overlaps, gaps, and opportunities for collaboration are addressed. In particular, participation in some current coordination mechanisms is

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inconsistent, and information on user needs, validated CB defense equipment requirements, and on how programs relate R&D projects to those needs is incomplete.

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**Programs Pursue Similar Capabilities and May Employ Many of the Same Laboratories**

As emphasized in a recent National Academy of Sciences study,<sup>8</sup> overlapping R&D activities among different agencies, while common and valuable, would be enhanced by effective coordination to reduce potential inefficient duplication of effort, prevent important questions from being overlooked, and enhance opportunities for collaboration. The National Academy of Sciences study advocated a formal process to coordinate areas of research that are supported by multiple agencies.

In the case of R&D to address CB threats, every R&D area is addressed by at least two of the four programs we examined. For example, all four programs address the capability for biological agent detection and identification, and three of the four programs address the capability for chemical detection and identification. Furthermore, programs sometimes develop similar technologies in pursuing these capabilities, such as mass spectroscopy for identifying biological agents. A summary of the R&D areas pursued by each program is presented in figure 2.

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<sup>8</sup>Evaluating Federal Research Programs: Research and the Government Performance and Results Act, National Research Council, National Academy Press, 1999.



**Figure 2: CB-related Subject Areas Covered by R&D Programs**

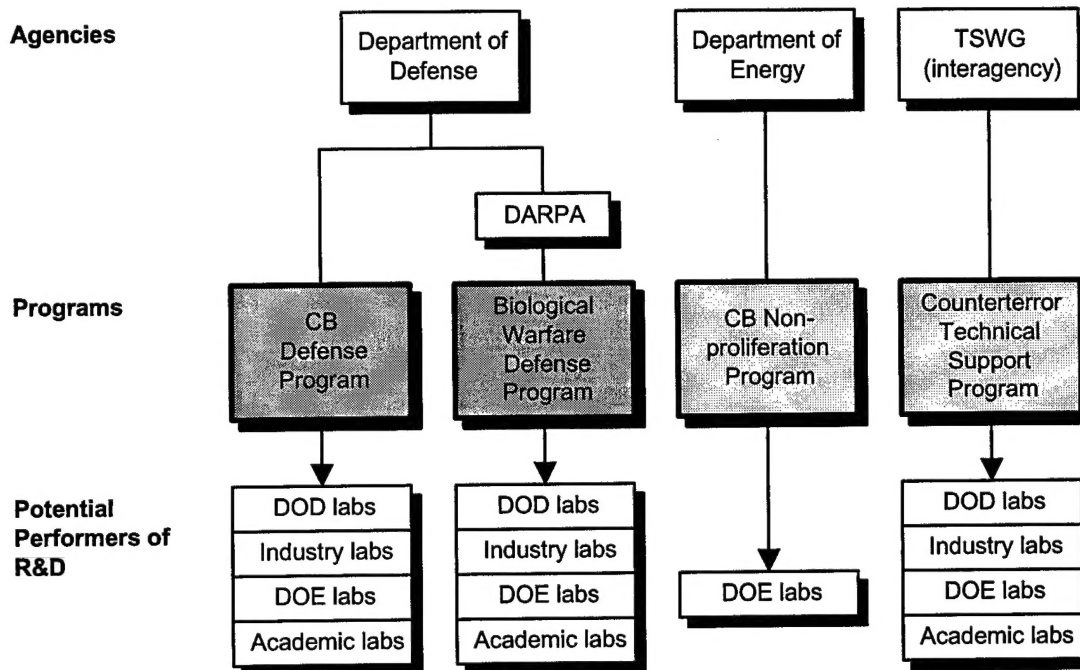
R&D area	DOD's Chemical and Biological Defense Program	DARPA's Biological Warfare Defense Program	DOE's Chemical and Biological Nonproliferation Program	TSWG's Counterterror Technical Support Program
Biological detection and identification	X	X	X	X
Chemical detection and identification	X		X	X
Individual protection	X			X
Collective protection	X			X
Decontamination, restoration, and mitigation	X		X	X
Modeling and simulation	X		X	X
Other applied research (e.g., threat assessment, aerosol technology)	X		X	
Other basic research (e.g., aerosol science, genomic sequencing)	X		X	

Note: An X indicates that the program covers the specified R&D subject area, by either funding or soliciting for (e.g., through a broad agency announcement) R&D projects in that area. A blank indicates that the program does not cover the specified R&D subject area.

Sources: DOD, DARPA, DOE, and TSWG.

In addition, programs may contract with the same groups of laboratories to perform R&D. Laboratories in DOD, industry, and academia may perform R&D work for three of the four programs, and DOE laboratories may perform work for any of the programs. A summary of the relationships among the agencies, programs, and potential R&D performers is presented in figure 3.

**Figure 3: Summary of Organizational Relationships Among Agencies, Programs, and Potential R&D Performers for Nonmedical R&D Addressing CB Threats**



Sources: DOD, DARPA, DOE, and TSWG.

### Participation in Coordination Mechanisms Is Inconsistent

Both formal and informal mechanisms are used to coordinate R&D among these four programs. One formal coordinating body involved with both military and domestic preparedness programs is the Counterproliferation Program Review Committee. This Committee, which consists of representatives from DOD, DOE, and the intelligence community, is responsible for annually reviewing and making recommendations to Congress regarding programs related to military as well as terrorist threats from non-conventional weapons, including CB threats. In addition, the National Security Council has established a coordinating group for Weapons of Mass Destruction Preparedness, under which there is a subgroup for R&D. Other formal coordinating bodies, such as the Nonproliferation and Arms Control Technical Working Group and the

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National Security Council-sponsored TSWG, oversee narrower ranges of activities related to CB threats.<sup>9</sup>

Many officials cited the importance of informal coordination mechanisms, such as informal briefings, scientific conferences, and participation in each other's planning and review meetings.<sup>10</sup> Participation in some informal coordination mechanisms, however, is incomplete. For example, although DOE's program is aimed at domestic preparedness needs, planning and review of DOE projects have not involved potential users from the domestic preparedness community. And, moreover, no valid requirements have been defined for this community. In the case of DOD's CB Defense Program, although DOE is invited to participate in the R&D planning and review meetings, they have not consistently attended. DARPA officials cite insufficient staff to attend all potential planning and review meetings. Thus, informal coordination mechanisms have not ensured input from end users and agencies involved in addressing threats from CB weapons.

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### Current Coordination Mechanisms Lack Complete Information on User Needs and Requirements

The current coordination mechanisms utilize only limited information on civilian user needs, validated CB defense equipment requirements, and how programs relate R&D projects to user needs. Information on user needs and defined requirements may allow coordination mechanisms to compare the specific goals and objectives of R&D projects to better assess whether overlaps, gaps, and opportunities for collaboration exist.

DOD's CB Defense Program coordinates and consolidates information on the warfighting capabilities that military users require. These requirements initially take the form of broad needs, such as "individual protection" or "contamination avoidance." From these broad needs, users develop detailed system and coordinated performance requirements based on analyses of threats and military missions. With information on user needs, equipment requirements, and ongoing R&D, consolidation is possible. For instance, after the CB defense efforts of each of the four services were coordinated through the CB Defense Program, 44 service-specific

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<sup>9</sup>The Nonproliferation and Arms Control Technical Working Group addresses preventing and detecting the use of CB threats, but not responding to their use. The TSWG's scope only includes terrorist, not military, CB threats.

<sup>10</sup>As an example of the results of informal coordination, program officials repeatedly noted a project for detecting CB agents based on "parallel micro separations" that is funded jointly by DOD and DOE at the Sandia National Laboratory.

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developmental efforts in the program's contamination avoidance research area were consolidated into 10 joint-service projects.

Programs have significantly less information on domestic preparedness needs than on military needs. While military user needs and requirements are coordinated among the military services and are relatively detailed, domestic preparedness needs are uncoordinated and scantily defined. For example, the InterAgency Board for Equipment Standardization and InterOperability advising the National Domestic Preparedness Office at the Federal Bureau of Investigation has developed a Standardized Equipment List for first responders. Use of the list is voluntary, however, as there is neither a validated set of requirements nor a consensus in the domestic preparedness community on needed equipment.<sup>11</sup> Two lists of R&D needs to improve domestic capabilities to respond to CB incidents have been developed, but these lists are short statements of equipment needs without detailed performance specifications, and they do not incorporate mission and threat analyses.<sup>12</sup>

The coordinating mechanisms also lack sufficient information on how two of the four programs relate user needs to their program R&D goals. Only R&D projects conducted by DOD's CB Defense Program and the TSWG's Subgroup on Chemical, Biological, Radiological, and Nuclear Countermeasures are formally tied to user needs. One example of how DOD's R&D efforts are tied to user needs is the use of Defense Technology Objectives. Each Defense Technology Objective identifies a specific technology advancement that will be developed or demonstrated as well as the specific benefits to military operational capabilities from the technology advance. In other cases, R&D efforts are tied directly to performance specifications as part of the equipment acquisition cycle. In the case of TSWG, all R&D projects directly support the user needs developed within TSWG; though, as noted above, equipment needs are stated without detailed performance specifications, and they do not incorporate mission and threat analyses.

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<sup>11</sup>Combating Terrorism: Analysis of Potential Emergency Response Equipment and Sustainment Costs (GAO/NSIAD-99-151, June 9, 1999).

<sup>12</sup>A prioritized list of R&D needs to detect, protect from, and mitigate CB weapons is developed by TSWG annually; and, in a recent Institute of Medicine study, Chemical and Biological Terrorism: Research and Development to Improve Civilian Medical Response, the nonmedical R&D needs of civilian health providers were delineated (e.g., personal protective equipment, detection and measurement of chemical agents).

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The DARPA and DOE programs, by contrast, do not formally incorporate user needs in planning their R&D efforts. Each DARPA R&D area is internally developed by DARPA and does not necessarily support a documented military requirement. Proposals in each area are evaluated by a peer review panel consisting primarily of nongovernment experts, and the final decision for funding a proposal is made by the DARPA program manager for that R&D area. Similarly, the planning and review of DOE projects do not utilize any requirements developed for domestic preparedness programs. Project reviews are primarily concerned with technical merit, although potential user benefits are considered. Review panels consisted primarily of DOE personnel in 1997-98, and are planned to consist of non-DOE technical experts in 1999.

Agency officials are aware of the deficiencies in the existing coordination mechanisms, and some have initiated additional informal contacts in response. Informal coordination between DOD and DOE has been particularly active.

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## Agency Comments and Our Evaluation

We provided a draft of our report to DOD and DOE. DOD provided technical comments, which we incorporated into our report, where appropriate. In a written response, DOE stated that they had no comments with our report as written. DOE's response is reprinted in appendix I.

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## Scope and Methodology

The scope of our study was limited to federally funded R&D of nonmedical technologies to address CB threats. We did not evaluate any classified R&D.

To address objective (1), to identify federal programs funding R&D in this area, we conducted interviews, literature searches, and collected program documents. We queried officials from the Department of Defense, Department of Energy, the Technical Support Working Group, and the White House Office of Science and Technology Policy. We also conducted searches of Department of Defense databases, governmentwide databases, and the Commerce Business Daily. In addition, we reviewed recent legislation addressing the threat from chemical and biological weapons to both the military and civilians, including legislation establishing new programs in this area. Program documents we examined included program budgets, strategic and performance plans, annual reports, internal program

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planning documents, program briefings, and proceedings to program review meetings.

For objective (2), to describe the mechanisms for coordinating these programs, we interviewed program officials, examined legislation and program documents, observed program review meetings, and attended scientific conferences. Our interviews included discussions of formal coordination mechanisms as well as informal mechanisms. We also reviewed legislation establishing formal coordinating bodies and documents produced by these bodies. This documentation included annual reports, briefing slides, and documentation made available on the world wide web. Our assessment of informal coordination included our observation of interagency participation in program meetings and scientific conferences. We observed a 1999 TSWG requirements determination meeting as well as the 1999 DOD Technology Area Review and Assessment of CB defense. Scientific conferences we attended included the 1998 Joint Workshop on Standoff Detection for Chemical and Biological Defense and the 1998 Scientific Conference on Chemical and Biological Defense Research. We also obtained proceedings from these and other scientific conferences from previous years.

We contacted the following organizations:

- Defense Advanced Research Projects Agency, Arlington, Virginia;
- Defense Threat Reduction Agency, Dulles, Virginia;
- Department of Energy, Washington, D.C.;
- Office of the Director, Defense Research and Engineering, Washington, D.C.;
- Edgewood Chemical and Biological Center, Aberdeen Proving Ground, Maryland;
- Joint Program Office for Biological Defense, Falls Church, Virginia;
- National Domestic Preparedness Office, Washington, D.C.;
- National Ground Intelligence Center, Charlottesville, Virginia;
- Nonproliferation and National Security Office, Department of Energy, Washington, D.C.;
- Office of Science and Technology Policy, White House, Washington, D.C.;
- Office of the Secretary of Defense, Washington, D.C.;
- Technical Support Working Group, Fort Washington, Maryland;
- U.S. Army Soldier and Biological Chemical Command, Aberdeen Proving Ground, Maryland; and
- U.S. Army Training and Doctrine Command, Fort Monroe, Virginia.

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We conducted our evaluation from November 1998 to April 1999 in accordance with generally accepted government auditing standards.

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As agreed with your offices, unless you publicly announce its contents earlier, we plan no further distribution of this report until 7 days after its issue date. At that time, we will send copies to other congressional committees and the Secretary of Defense and the Secretary of Energy. We will also make copies available to others on request.

If you have any questions regarding this letter, please contact me or Sushil K. Sharma at (202) 512-3092. Key contributors to this report were Weihsueh Chiu and Jeffrey Harris.

A handwritten signature in black ink, appearing to read 'Kwai-Cheung Chan', with a stylized flourish at the end.

Kwai-Cheung Chan  
Director, Special Studies and Evaluations





# Comments from the Department of Energy



**Department of Energy**

Washington, DC 20585

June 30, 1999

Dr. Sushil Sharma  
Assistant Director, Special Studies and Evaluations  
National Security and International Affairs Division  
U.S. General Accounting Office  
Washington, D.C. 20584

Dear Dr. Sharma:

The Department of Energy appreciates the opportunity to review the draft report on the Department of Defense's chemical and biological defense programs. We understand that this report, NSIAD-99-160, "CHEMICAL AND BIOLOGICAL DEFENSE: Coordination of R&D for Military and Domestic Preparedness Programs," is one of two reports being issued on this subject. The Office of the Assistant Secretary for Nonproliferation and National Security, and specifically the Office of Research and Development, has no comments with this report as written.

Sincerely,

A handwritten signature in black ink, reading "R. Waldron", is positioned above the printed name and title of the signatory.

Robert E. Waldron  
Director  
Office of Research and Development  
Office of the Assistant Director for  
Nonproliferation and National Security



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